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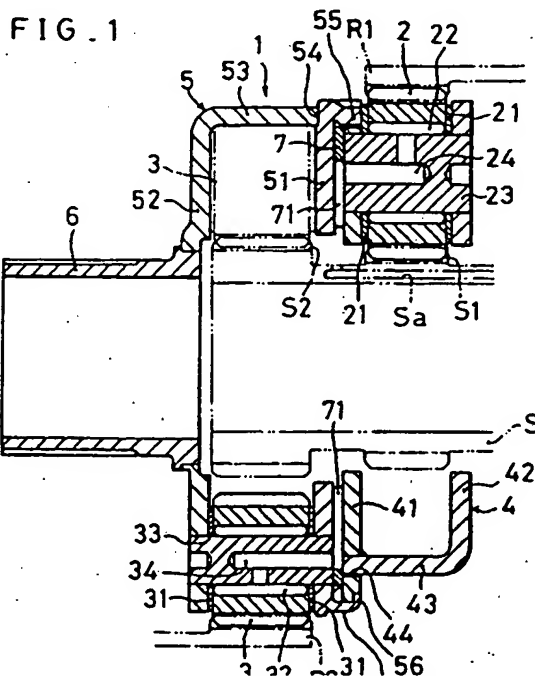
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(54) Lubrication of double planetary carrier.

(57) A double planetary carrier (1) is constructed by providing separate carriers (4, 5) for carrying therein two sets of planet gears (2, 3) which are axially set apart from each other, and by connecting the two carriers (4, 5) together. A cylindrical portion (51a) is formed on a periphery of a side plate (51) of one (5) of the carriers to receive therein a side plate (41) of the other carrier (4). Between the side plates (41, 51) there are formed radially extending oil grooves (71) to introduce lubricating oil into oil holes (24, 34) which are formed in gear shafts (23, 33) of the planet gears (2, 3).



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FIG. 1 is a schematic diagram of a circular gear assembly. The assembly consists of a central gear (42) surrounded by four smaller gears (23) arranged in a ring. The entire assembly is housed within a circular frame (1). The frame has an outer rim (4) and an inner rim (43). The gears are mounted on shafts (44) and are connected by a common drive shaft (45). The gears have teeth (2) and are labeled with various reference numerals: 1, 2, 23, 4, 41, 42, 43, 44, 45, 51a, 55, 56.

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FIG. 3

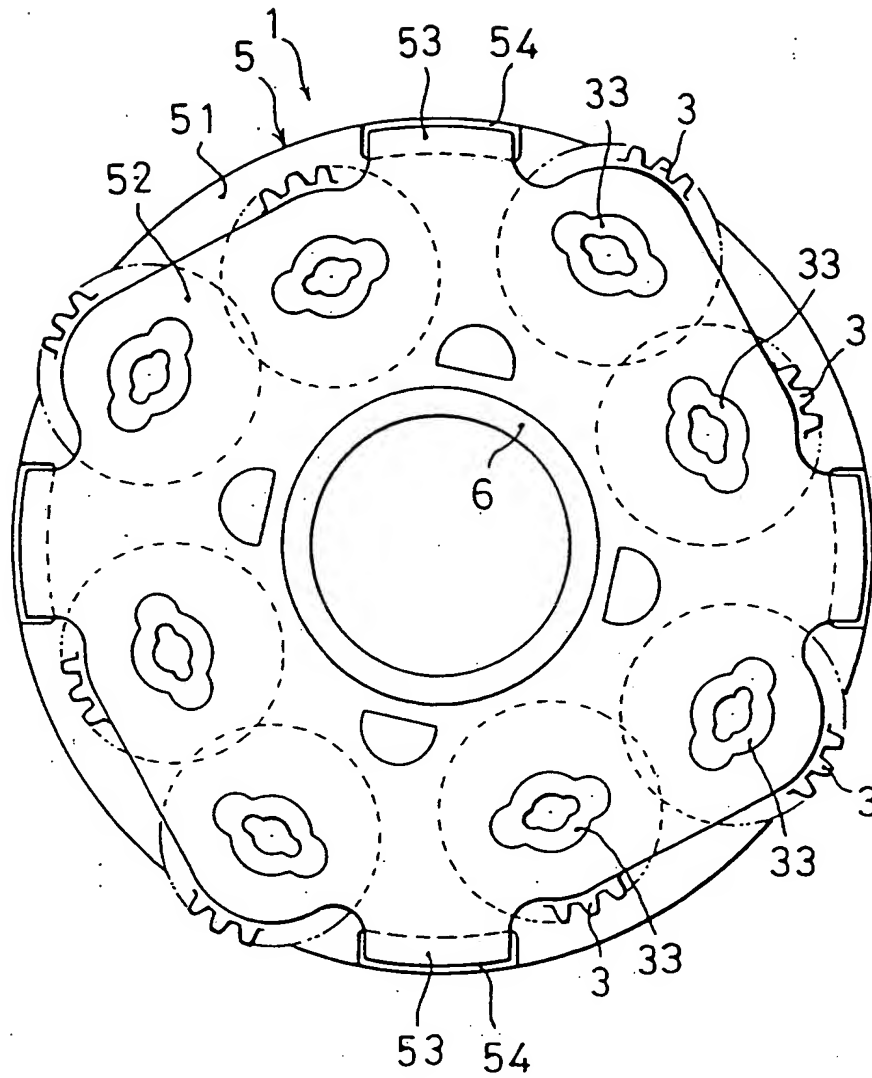


FIG. 4

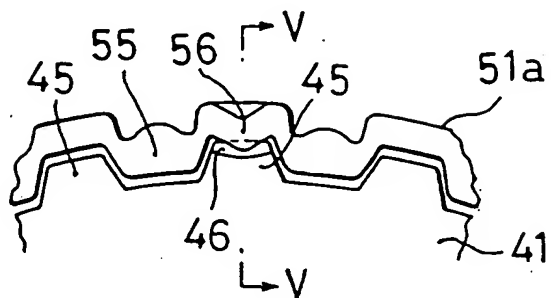


FIG. 5

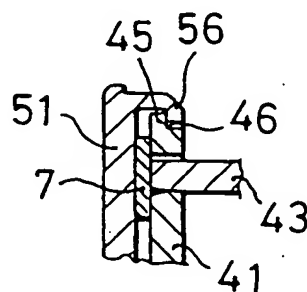
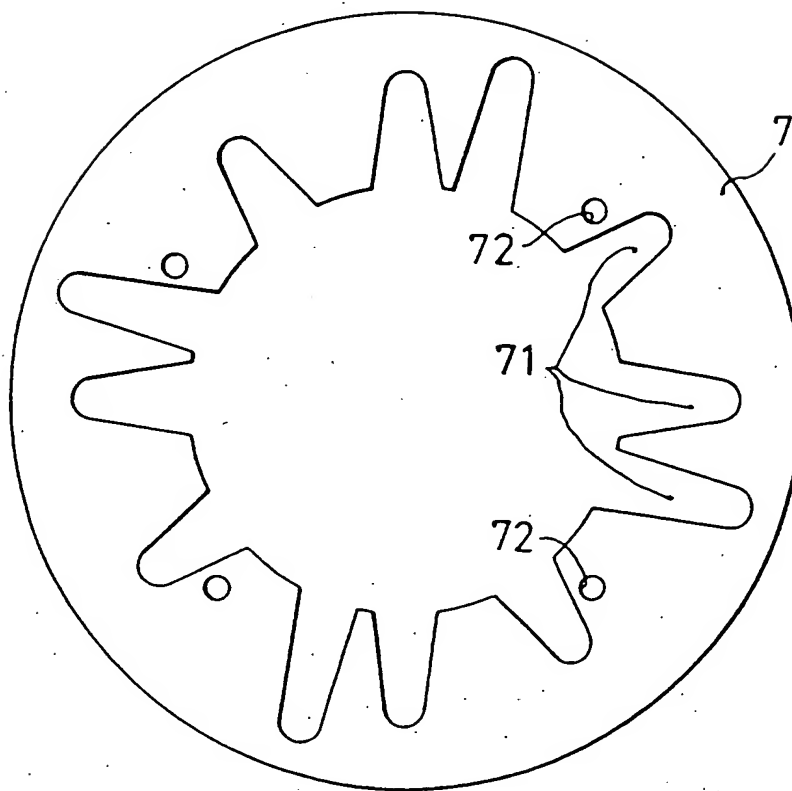


FIG. 6



LUBRICATION OF DOUBLE PLANETARY CARRIER

The present invention relates to apparatus for lubricating a double planetary carrier.

A double planetary carrier, is described in
5 Japanese Published Unexamined Utility Model
Registration Application No. 121451/1987. In this
carrier, three side plates are disposed with an axial
distance from each other. These side plates are
integrally connected together via intermediate pieces
10 which are interposed between the side plates. Planet
gears are carried in a respective space between the
intermediate side plate and the two side plates which
are positioned on both axially outer sides thereof.

An ordinary planetary carrier, which carries one
15 set of planet gears, is assembled as follows. Namely,
planet gears are inserted into the space between a pair
of side plates which are connected together via
intermediate pieces. Gear shafts for rotatably
supporting the gears are then assembled to extend
20 across both side plates. Both ends of the gear shafts
are thereafter caulked to fix the gear shafts to the
carrier.

However, in the above-described conventional
double planetary carrier in which three side plates are
25 integrally connected together, it is impossible to
caulk those fitting ends of the gear shafts against the
intermediate side plate. Therefore, the fitting ends
of the gear shafts against the outer side plates have
to be welded to the outer side plates to fix the gear
30 shafts to the carrier. It follows that the welding of
the gear shafts is time-consuming and the productivity
becomes poor.

In order to eliminate this kind of disadvantage,
the following arrangement may be considered. Namely,
35 two carriers, each having a pair of side plates which
are connected together via intermediate pieces, are

provided so as to carry planet gears in each of them, and these two carriers are connected together to constitute a double planetary carrier.

The lubrication between the gear shafts for
5 rotatably supporting the planet gears and the planet gears is conventionally carried out in the following manner. Namely, each gear shaft is supported in a throughgoing manner by penetrating it through side plates of the carrier. A blind oil hole is drilled on
10 an end surface of each gear shaft so as to extend along the axial line of the gear shaft. A small oil hole is provided to communicate a substantially central portion of a cylindrical surface, which is a bearing portion of the gear shafts, with the oil hole to thereby supply
15 the bearing portion with lubricating oil from the oil hole via the small oil hole. However, the lubricating oil will not enter the oil hole by simply opening the oil hole in the end surface of each gear shaft. As a solution, as described in Japanese Published Unexamined
20 Utility Model Registration Application No. 117464/1979, the following arrangement is known.

Namely, a ring-like thin plate which covers, with a clearance, an end surface of each gear shaft is mounted such that its peripheral edge is closely attached to a
25 side plate of a carrier. A pocket-like space, to which an opening portion of an oil hole faces, is formed so that the lubricating oil entering the pocket-like space through centrifugal force can be introduced into the oil hole.

30 Suppose that the above-described conventional lubricating means is applied to the double planetary carrier which carries therein two sets of axially set apart planet gears as described in the above-described Published Unexamined Utility Model Registration
35 Application No. 121451/1987. Each oil hole is made to open, out of both end surfaces, into that end surface

of each gear shaft supporting each planet gear which lies on the outer side surface, and a ring-like thin plate is also provided on respective outer surfaces. However, since the ring-like thin plate must be mounted
5 with a clearance from the end surface of each gear shaft as described above, there is a disadvantage in that each of the ring-like thin plates protrudes out of the side plate and consequently that the axial dimension of the carrier becomes large.

10 In view of the above-described disadvantage, the present invention seeks to provide a double planetary carrier in which the gear shafts and the planet gears can sufficiently be lubricated without using the above-described ring-like thin plates.

15 According to the present invention, there is provided a double planetary carrier for carrying therein two sets of planet gears, one set being axially set apart from the other set, comprising: a first carrier having a pair of side plates which face each
20 other to support, in a throughgoing manner, gear shafts which rotatably support one set of said planet gears on one axial side, said side plates being connected together via intermediate pieces; and a second carrier having a pair of side plates which face each other to
25 support, in a throughgoing manner, gear shafts which rotatably support the other set of said planet gears on the other axial side, said side plates being connected together via intermediate pieces, the side plate on the other axial side of said first carrier being defined to
30 be a first side plate, the side plate on the one axial side of said second carrier being defined to be a second side plate; wherein said first side plate and said second side plate are connected together in a manner axially opposite to each other; each of said
35 gear shafts has an oil hole which opens into an end surface thereof which is exposed to facing surfaces of

said first side plate and said second side plate; and radial grooves are provided between said first side plate and said second side plate so as to reach opening portions of said respective oil holes.

5 According to this double planetary carrier, grooves to introduce by centrifugal force lubricating oil to the oil hole of each gear shaft are secured in that space between the first side plate and the second side plate which serves as a connecting portion between
10 the first carrier and the second carrier. Therefore, it becomes not necessary any more to mount a conventional ring-like thin plate on the axially outer side of each carrier. It is thus possible to shorten the axial dimension of the double planetary carrier
15 without impairing the ease with which the lubricating oil can be supplied.

It is acceptable to cut or provide grooves on the facing surfaces of the first side plate and the second side plate respectively. However, if an oil plate
20 provided with radial grooves is interposed between the two side plates, the grooves can be easily and advantageously secured.

For a better understanding of the invention, and to show how it may be carried into effect, reference
25 will now be made, by way of example, to the accompanying drawings in which:

Fig. 1 is a vertical sectional view of one embodiment of a double planetary carrier according to the present invention;

30 Fig. 2 is a right-side side view thereof;

Fig. 3 is a left-side side view thereof;

Fig. 4 is an enlarged view of a serrated connecting portion between a first carrier and a second carrier;

35 Fig. 5 is a sectional view taken along the line V-V in Fig. 4;

Fig. 6 is a side view of an oil plate to be interposed between the two carriers; and

Fig. 7 is a partial sectional view of another embodiment of the oil plate.

5 Referring to Figs. 1 through 3, numeral 1 denotes a double planetary carrier. Two sets of planet gears 2, 3 which are axially set apart (or set apart in an axial direction) from each other are carried in the carrier 1.

10 The carrier 1 is made up by connecting together a first carrier 4 for carrying therein four pieces of planet gears 2 which are disposed on axially one side and a second carrier 5 for carrying therein four pairs of dual planet gears 3 which are disposed on axially
15 the other side. The two sets of planet gears 2, 3 are engaged with sun gears S1, S2 which are mounted on a common sun gear shaft S, as well as with respective ring gears R1, R2, thus constituting a planetary gear mechanism. An output is taken out via a hub 6 which is
20 mounted on the second carrier 5.

The first carrier 4 and the second carrier 5 are provided with side plates 41, 51 which are positioned on an axially inner side and side plates 42, 52 which are positioned on an axially outer side. Each of the
25 carriers 4, 5 is made by welding front ends of intermediate pieces 43, 53 which are formed by bending axially inwards in a plurality of positions in the circumference of the outer side plates 42, 52, to the inner side plates 41, 51. In the first carrier 4, a
30 plurality of connecting holes 44 are formed in the inner side plate 41. The front end of each intermediate piece 43 is respectively inserted into the hole 44 and is welded together. In the second carrier 5, a plurality of coining-finished seats (or seats
35 which are subjected to mechanical finishing of coining) 54 are formed on the rear surface of the inner side

plate 51. The front end of each intermediate piece 53 is abutted to the coining-finished seats 54 to weld them together.

After each of the carriers 4, 5 has been
5 manufactured as described above, each set of planet gears 2, 3 are inserted into the space between both side plates of each carrier 4, 5 in a condition in which washers 21, 31 are placed in contact with both
10 ends of the planet gears. Then, gear shafts 23, 33 which penetrate through needle bearings 22, 32 mounted on an inner circumference of the planet gears 2, 3 are assembled so as to extend across both side plates. Both ends of the respective gear shafts 23, 33 are then
15 caulked to fix them to the respective carriers 4, 5, thereby assembling the carrier assembly. On a periphery of the inner side plate 51 of the second carrier 5, there is formed a cylindrical portion 51a for receiving therein the inner side plate 41 of the first carrier 4 which lies to face the side plate
20 51. Outward-projecting and inward-projecting serrated teeth 45, 55 are respectively formed on the periphery of the side plate 41 and on the cylindrical portion 51a so that the first and the second carriers 4, 5 may be serration-engaged or engaged by means of serrations.

25 As shown in Figs. 4 and 5, in a plurality of circumferential portions of the rear surface of the side plate 41 of the first carrier 4, there are formed dented groove portions 46 which are positioned in tooth crest portions of the serrated teeth 45. A plurality
30 of circumferential portions at the tip of the cylindrical portion 51a are caulked diametrically inwards at tooth bottom portions of the serrated teeth 55. These caulked portions 56 are engaged with the dented groove portions 46 so as to connect the two
35 carriers 4, 5 axially immovably, thereby constituting the double planetary carrier 1. The following

arrangement may also be employed. Namely, the cylindrical portion 51a is formed in a manner to project towards the rear side of the side plate 41. On the internal circumference of this projected portion, a
5 circlip to be engaged with the rear surface of the side plate 41 is mounted to thereby axially connect both carriers 4, 5.

The above-described serrated teeth 45, 55 are formed, as shown in Fig. 4, so as to be engaged with
10 each other with a play therebetween. Therefore, when the two sets of planet gears 2, 3 are to be engaged with the sun gears S1, S2, the two carriers 4, 5 are moved relative to each other so that the two sets of planet gears 2, 3 are automatically aligned relative to
15 the sun gears S1, S2.

Between the inner side plates 41, 51 of both carriers 4, 5 there is interposed an oil plate 7 which is made of rubber and has formed therein a plurality of radial oil grooves 71 as shown in Fig. 6. This oil
20 plate 7 is so arranged as to supply lubricating oil to be supplied from an oil hole Sa formed in the sun gear shaft S, via each of the oil grooves 71, to oil holes 24, 34 which are formed in the gear shafts 23, 33 of the respective planet gears 2, 3. The oil holes 24, 34
25 are arranged to open into those end surfaces of the respective gear shafts which are exposed to the facing surfaces of the side plates 41, 51. As illustrated, the diameter of the inner fringe of the oil plate 7 is made slightly larger than the diameter of the inner
30 fringe of the side plates 41, 51 so that the lubricating oil to be supplied from the oil hole Sa can be guided by the inner fringe of the side plates 41, 51 and is introduced into the oil grooves 71 in the oil plate 7. In the oil plate 7 there are provided
35 positioning holes 72 for engaging them to protrusions (not illustrated) which are so provided as to extend

from one of the side plates 41, 51.

In the above-described embodiment, the oil grooves 71 are cut so as to open into both sides of the oil plate 7. However, as shown in Fig. 7, oil grooves 71a, 71b may be provided so as to alternately open into one side surface and the other side surface of the oil plate 7. In such an arrangement, the oil grooves 71a, 71b are formed by a suitable method such, for example, as cutting, pressforming, or the like. The oil plate 7 is not limited to rubber in material, but may be formed of steel plate, aluminum plate, synthetic resin plate, or the like.

In the above-described embodiments, the first and the second carriers 4, 5 are arranged to be engaged by means of serrations. However, there will be cases where the first and the second carriers 4, 5 are connected by inserting a connecting pin to extend across the side plates 41, 51 or where the side plates 41, 51 are connected by welding. The above-described lubricating means is also applicable to those cases.

A double planetary carrier substantially as described herein is also described and claimed in British Patent Application No. 9318033.9 (Publication No. 2270732).

CLAIMS

1. A double planetary carrier for carrying therein two sets of planet gears, one set being axially set apart from the other set, comprising:

5 a first carrier having a pair of side plates which face each other to support, in a throughgoing manner, gear shafts which rotatably support one set of said planet gears on one axial side, said side plates being connected together via intermediate pieces;

10 a second carrier having a pair of side plates which face each other to support, in a throughgoing manner, gear shafts which rotatably support the other set of said planet gears on the other axial side, said side plates being connected together via intermediate
15 pieces, the side plate on the other axial side of said first carrier being defined to be a first side plate, the side plate on the one axial side of said second carrier being defined to be a second side plate;

wherein said first side plate and said second side
20 plate are connected together in a manner axially opposite to each other;

each of said gear shafts has an oil hole which opens into an end surface thereof which is exposed to facing surfaces of said first side plate and said
25 second side plate; and

radial grooves are provided between said first side plate and said second side plate so as to reach opening portions of said respective oil holes.

2. A double planetary carrier according to claim
30 1, further comprising an oil plate which has formed therein said radial grooves and is interposed between said first side plate and said second side plate.

3. A double planetary carrier according to claim 2, wherein each of said radial grooves is formed to
35 open into both side surfaces of said oil plate.

4. A double planetary carrier according to claim

2, wherein said radial grooves are formed to alternately open into one side surface and the other side surface of said oil plate.



The Patent Office

Application No: GB 9525533.7
Claims searched: 1-4

Examiner: Alan Habbijam
Date of search: 25 January 1996

Patents Act 1977 Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2Q

Int Cl (Ed.6): F16H 1/28, 1/32, 57/04, 57/08.

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
	NONE	

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.

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E Patent document published on or after, but with priority date earlier than, the filing date of this application.